We claim:

1) A power combiner having:

a central axis about which is disposed a plurality of cylindrical feed waveguides, each said feed waveguide having a radius, an input port and a launching port, all centered on a feed waveguide axis, said launching port including a cylindrical section formed by sweeping a line of length L_{launch} and said radius through an included angle α;

a plurality of focusing reflectors, one for each said feed waveguide, each said focusing reflector centered on said feed waveguide axis;

a cylindrical final waveguide coaxial to said central axis and collecting power reflected by each said focusing reflector.

2) The power combiner of claim 1 where said feed waveguide axis is parallel to said central axis.

3) The power combiner of claim 1 where each said feed waveguide radius is equal to each other said feed waveguide radius.

4) The power combiner of claim 1 where at least one said feed waveguide radius is different from any other said feed waveguide radius.

5) The power combiner of claim 1 where said feed waveguide launching port cylindrical section is convex to said central axis, and said corresponding reflector is concave to said central axis.

6) The power combiner of claim 5 where said feed waveguide cylindrical section and said reflector are symmetrically arranged with respect to a plane from said central axis to said feed guide center axis.

7) The power combiner of claim 5 where said feed waveguide cylindrical section and said reflector are asymmetrically arranged with respect to a plane from said central axis to said feed guide center axis.

8) The power combiner of claim 1 where said feed guide launching port cylindrical section is concave to said central axis, and said corresponding reflector is convex to said central axis.

9) The power combiner of claim 8 where said feed waveguide cylindrical section and said reflector are symmetrically arranged with respect to a plane from said central axis to said feed guide center axis.

10) The power combiner of claim 8 where said feed waveguide cylindrical section and said reflector are asymmetrically arranged with respect to a plane from said central axis to said feed guide center axis.

11) The power combiner of claim 1 where said launch port has a length L_{launch}, where

$$L_{launch} = 2\pi R_{feed}\{k_{par}\,\mathrm{sqrt}\{1-(m/X_{mn})^2\}/\{k_{perp}\cos^{-1}(m/X_{mn})\}$$

where

k_{par} is the parallel, or axial wave number

R_{feed} is said radius of said feed waveguide

m is the azimuthal index of the mode in said feed waveguide

n is the radial index of the mode in said feed waveguide

X_{mn} is the eigenvalue of the mode

K_{perp} is the perpendicular wave number.

12) The power combiner of claim 1 where said launch port included angle is between 160 and 200 degrees.

13) The power combiner of claim 1 where said reflector is formed by a curve extruded along said central axis, said reflector curve comprising a locus of points.

14) The power combiner of claim 13 where said locus of points satisfies the following criteria, where a first focus is located on said central axis, and a second focus is located at the center of said feed waveguide:

a) the sum of the path length from said first focus to any given locus point and from said given locus point to said second focus point is a constant,

b) at each locus point, an intersection point is defined by the intersection of said locus point, a tangent line which is tangent to said reflector curve at said locus point, and a perpendicular line which is perpendicular to said tangent line at said locus point, said perpendicular line bisecting the angle formed by a line from said intersection point to said first focus and said intersection point to said second focus.

15) The power combiner of claim 1 where said plurality comprises k feed waveguides and k reflectors, and the angular extent of each said reflector is 360/k degrees with respect to said central axis.

16) The power combiner of claim 1 where each said input waveguide is coupled to a source of symmetric traveling wave power, said input power traveling through each feed waveguide, reflecting from said reflector and collected in said final waveguide.

17) A power splitter comprising the power combiner of claim 1 where said final waveguide is coupled to a source of traveling wave power, said traveling wave power exiting said final waveguide at a reflector end, reflecting from each said reflector and thereafter coupling to each said feed waveguide launch port, delivering traveling wave power to each said input port.

18) The power splitter of claim 18 where the power applied to said final waveguide splits uniformly between each said feed waveguide input port.

19) The power splitter of claim 18 where the power applied to said final waveguide splits unevenly between at least one said feed waveguide and any other said feed waveguide.

20) A power combiner having:

a central axis about which is disposed a plurality k of cylindrical feed waveguides, each said feed waveguide having a radius, an input port and a launching port, all centered on a feed waveguide axis, said launching port including a cylindrical helix;

a plurality k of focusing reflectors, one for each said feed waveguide, each said focusing reflector centered on said feed waveguide axis;

a final waveguide coaxial to said central axis and collecting power reflected by each said focusing reflector with a proximal final waveguide reflector port, said final waveguide reflector port including a multi-cut helix having k cuts.

21) The power combiner of claim 20 where

$(1/\pi)$ arc cos (m/X_{mn}) is not an integer, when

said m = azimuthal wave number

said m = radial wave number

said X_{mn} = the eigenvalue of the mode.

22) The power combiner of claim 20 where said feed guide launch port helical section is formed by sweeping a line of length $L_{feedlaunch} = \theta * L_{feedhelix}/2\pi$ at said radius from and parallel to said feed guide axis, where $0 \leq \theta \leq 2\pi$ and θ is the angle in radians about said feed waveguide axis and said $L_{feedhelix}$ is the depth of the helical cut.

23) The power combiner of claim 20 where said final waveguide reflector port multi-cut helix is formed by the surface of rotation formed by sweeping a line of varying length $L_{finalmulticut}$ at said radius from said central guide axis about an angle θ;

thereafter joining end-for-end k said surfaces of rotation to form a cylindrical solid having k helical cuts

where

$L_{finalmulticut}=$

$(Lc/k)*(\theta /(k*2*pi))$ for $0 \leq \theta \leq 2*pi/k$

$Lc = 2\pi R_{final}\{k_{par}sqrt\{1-(p/X_{pq})^2\}\}/\{k_{perp}cos^{-1}(p/X_{pq})\}$

(Lc/k) is the multicut depth

k_{par} is the parallel, or axial wave number

R_{final} is the radius of the final waveguide

p is the azimuthal index of the mode in said final waveguide

q is the radial index of the mode in said final waveguide

X_{pq} is the eigenvalue of the mode

K_{perp} is the perpendicular wave number

k is the number of multicuts

24) The power combiner of claim 20 where said feed waveguide axis is parallel to said central axis.

25) The power combiner of claim 20 where each said feed waveguide radius is equal to each other said feed waveguide radius.

26) The power combiner of claim 20 where at least one said feed waveguide radius is different from any other said feed waveguide radius.

27) The power combiner of claim 20 where each said feed waveguide helical section angle θ =0 is uniformly offset with respect to a plane from said central axis to said feed guide center axis.

28) The power combiner of claim 20 where each said feed waveguide helical section angle $\theta = 0$ is not uniformly offset with respect to a plane from said central axis to said feed guide center axis.

29) The power combiner of claim 20 where said feed guide helical launch port has a helical cut depth $L_{feedlaunch}$

where

$L_{feedlaunch} = Lc$

$Lc = 2\pi R_{feed}\{k_{par}\text{sqrt}\{1-(m/X_{mn})^2\}/\{k_{perp}\cos^{-1}(m/X_{mn})\}$

R_{feed} is said feed guide radius

k_{par} is the parallel, or axial wave number

m is the azimuthal index of the mode in said feed guide

n is the radial index of the mode in said feed guide

X_{mn} is the eigenvalue of the mode

K_{perp} is the perpendicular wave number.

30) The power combiner of claim 20 where said final guide multicut port has a helical multi-cut depth

$L_{finalmulticut} = 2\pi\{k_{par}\text{sqrt}\{1-(p/X_{pq})^2\}/\{k_{perp}\cos^{-1}(p/X_{pq})\}$

where

k_{par} is the parallel, or axial wave number

p is the azimuthal index of the mode in said final guide

q is the radial index of the mode in said final guide

X_{pq} is the eigenvalue of the mode

K_{perp} is the perpendicular wave number.

31) The power combiner of claim 20 where said reflector is formed by a curve extruded along said central axis, said reflector curve comprising a locus of points.

32) The power combiner of claim 20 where said locus of points satisfies the following criteria for each given locus point:

where each said feed waveguide has a circular feed caustic and a feed caustic phase front, and said final guide has a circular final caustic and a final caustic phase front, for each point on said locus, a first line segment starting from said locus point, touching said feed caustic and ending on said feed caustic phase front, and a second line segment starting on said locus point, touching said final caustic and ending on said final caustic phase front:

a) the path length of said first line segment added to said second line segment is a constant,

b) at each said locus point, an intersection point is defined by the intersection of said locus point and a line which is tangent to said reflector curve at said locus point, and a perpendicular line which is perpendicular to said tangent line at said locus point, said perpendicular line bisecting the angle formed by said first line segment and said second line segment.

33) The power combiner of claim 20 where said plurality comprises k feed waveguides and k reflectors, and the angular extent of each said reflector about said central axis is 360/k degrees.

34) The power combiner of claim 20 where each said input waveguide is coupled to a source of asymmetric traveling wave power, said input power traveling through each feed waveguide, reflecting from said reflector and collected in said final waveguide.

35) A power splitter comprising the power combiner of claim 20 where said final waveguide is coupled to a source of traveling wave power, said traveling wave power exiting

said final waveguide, reflecting from each said reflector and thereafter coupling to each said feed waveguide launch port, and delivering traveling wave power to each said input port.

36) The power splitter of claim 34 where the power applied to said final waveguide splits evenly between each said feed waveguide input port.

37) The power splitter of claim 34 where the power applied to said final waveguide splits unevenly between at least one said feed waveguide and any other said feed waveguide.

38) A power combiner having:

a central axis about which is disposed a plurality k of cylindrical feed waveguides, each said feed waveguide having a radius, an input port and a launching port, all centered on a feed waveguide axis, said launching port including a cylindrical helix;

a plurality k of focusing reflectors, one for each said feed waveguide, each said focusing reflector centered on said feed waveguide axis;

a final waveguide coaxial to said central axis and collecting power reflected by each said focusing reflector with a proximal final waveguide reflector port.

39) The power combiner of claim 38 where

$(1/\pi)$ arc cos (p/X_{pq}) is an integer, when

said p = azimuthal wave number

said q = radial wave number

said X_{pq} = the eigenvalue of the mode.

40) The power combiner of claim 38 where said feed guide launch port helical section is formed by sweeping a line of length $L_{feedlaunch} = \theta * L_{launch}/2*pi$ at said radius from and parallel to said feed guide axis, where θ is the angle in radians about said feed waveguide axis and said L_{launch} is the length of the helical cut.

41) The power combiner of claim 38 where said final waveguide is a cylinder.

42) The power combiner of claim 38 where said feed waveguide axis is parallel to said central axis.

43) The power combiner of claim 38 where each said feed waveguide radius is equal to each other said feed waveguide radius.

44) The power combiner of claim 38 where at least one said feed waveguide radius is different from any other said feed waveguide radius.

45) The power combiner of claim 38 where each said feed waveguide helical section angle $\theta = 0$ is uniformly offset with respect to a plane from said central axis to said feed guide center axis.

46) The power combiner of claim 38 where each said feed waveguide helical section angle $\theta = 0$ is not uniformly offset with respect to a plane from said central axis to said feed guide center axis.

47) The power combiner of claim 38 where said feed guide helical launch port has a helical cut depth

$$L_{feedlaunch} = 2\pi\{k_{par}\,sqrt\{1-(m/X_{mn})^2\}/\{k_{perp}\cos^{-1}(m/X_{mn})\}$$

where

k_{par} is the parallel, or axial wave number

m is the azimuthal index of the mode in said feed guide

n is the radial index of the mode in said feed guide

X_{mn} is the eigenvalue of the mode

K_{perp} is the perpendicular wave number.

48) The power combiner of claim 38 where said final guide multicut port has a helical multi-cut depth $L_{finalmulticut}$ $=2\pi\{k_{par}\text{sqrt}\{1-(p/X_{pq})^2\}/\{k_{perp}\cos^{-1}(p/X_{pq})\}$ where

k_{par} is the parallel, or axial wave number

p is the azimuthal index of the mode in said final guide

q is the radial index of the mode in said final guide

X_{mn} is the eigenvalue of the mode

K_{perp} is the perpendicular wave number.

49) The power combiner of claim 38 where said reflector is formed by a curve extruded along said central axis, said reflector curve comprising a locus of points.

50) The power combiner of claim 38 where said locus of points satisfies the following criteria for each given locus point:

where each said feed waveguide has a circular feed caustic and a feed caustic phase front, and said final guide has a circular final caustic and a final caustic phase front, for each point on said locus, a first line segment starting from said locus point, touching said feed caustic and ending on said feed caustic phase front, and a second line segment starting on said locus point, touching said final caustic and ending on said final caustic phase front:

a) the path length of said first line segment added to said second line segment is a constant,

b) at each said locus point, an intersection point is defined by the intersection of said locus point and a line which is tangent to said reflector curve at said locus point, and a perpendicular line which is perpendicular to said tangent line at said locus point, said perpendicular line bisecting the angle formed by said first line segment and said second line segment.

51) The power combiner of claim 38 where said plurality comprises k feed waveguides and k reflectors, and the angular extent of each said reflector about said central axis is 360/k degrees.

52) The power combiner of claim 38 where each said input waveguide is coupled to a source of asymmetric traveling wave power, said input power traveling through each feed waveguide, reflecting from said reflector and collected in said final waveguide.